

Rethinking Resilience – The Underground Option

ARPA-E Undergrounding Workshop

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Vision

To be a world leader in advancing science and technology solutions for a clean energy future

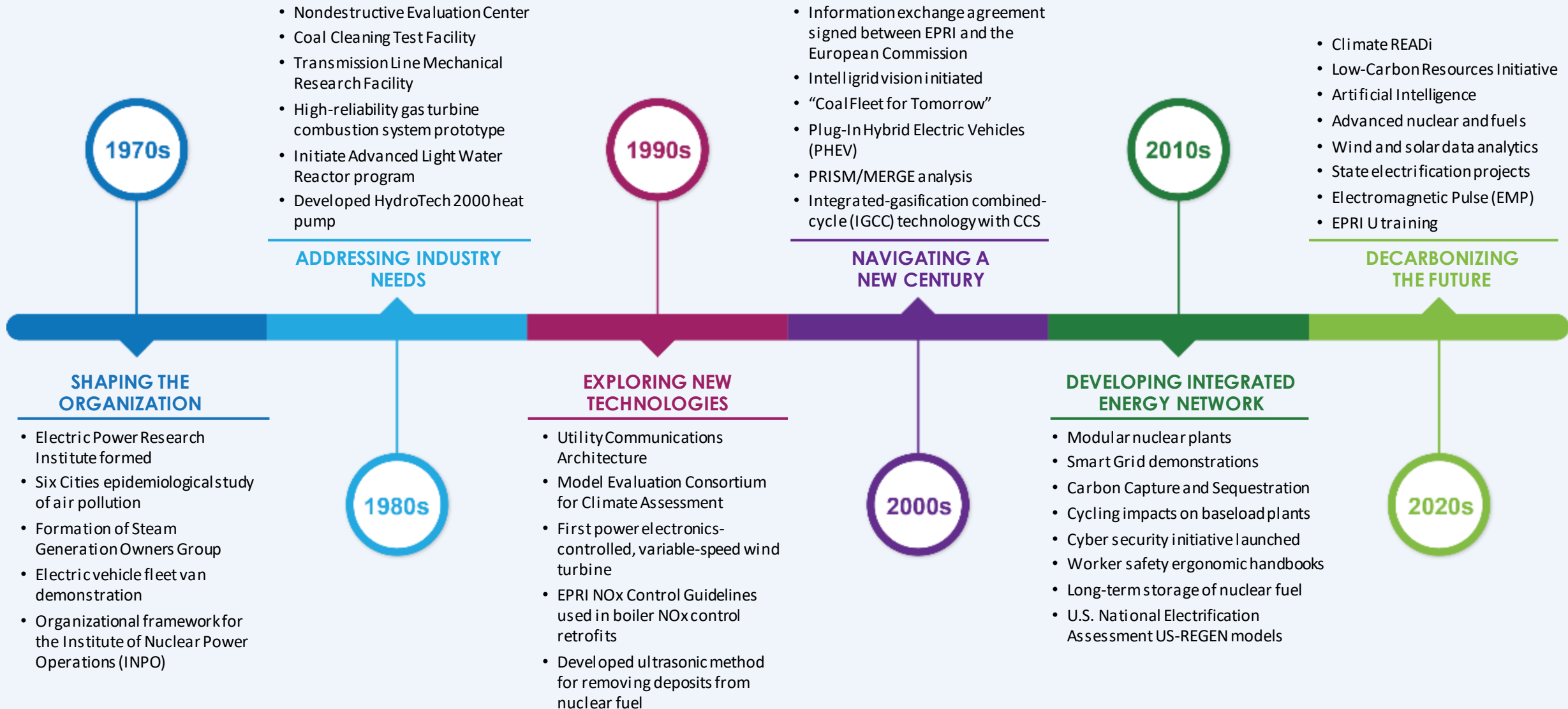
Mission

Advancing safe, reliable, affordable, and clean energy for society through global collaboration, science and technology innovation, and applied research.

Together...Shaping the Future of Energy®



EPRI's Technology Milestones Over the Decades





Nonprofit

Chartered to serve the public benefit, with guidance from an independent advisory council.



Thought Leadership

Systematically and imaginatively looking ahead to identify issues, technology gaps, and broader needs that can be addressed by the electricity sector.



Independent

Objective, scientific research leading to progress in reliability, efficiency, affordability, health, safety, and the environment.



Scientific and Industry Expertise

Provide expertise in technical disciplines that bring answers and solutions to electricity generation, transmission, distribution, and end use.



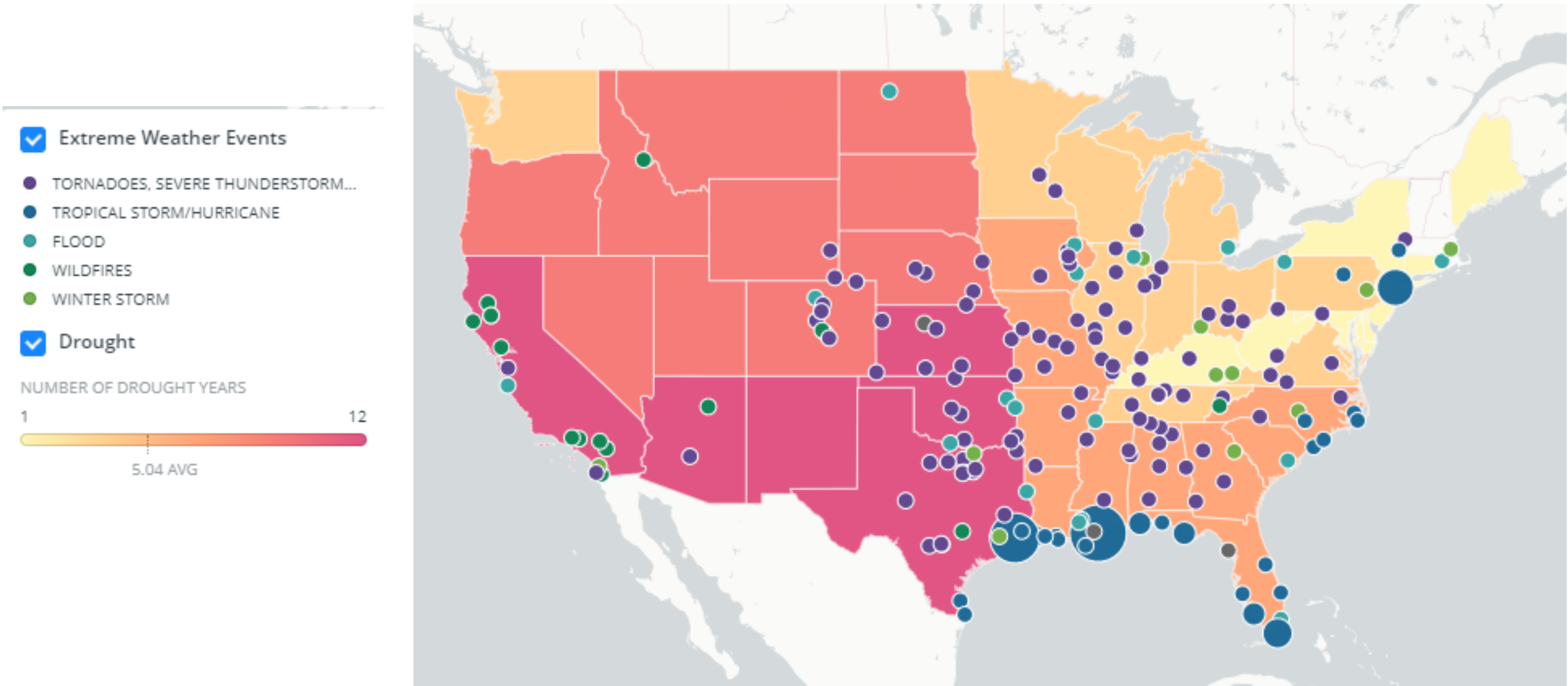
Collaborative Value

Bring together our members and diverse scientific and technical sectors to shape and drive research and development in the electricity sector.

All overhead systems remain exposed to major weather stressors



Extreme Weather on the Rise



<https://www.c2es.org/content/extreme-weather-and-climate-change/>

Increased need for resilience

Changing
customer
expectations

Increase in
electrification

Dependence
on grid for
enabling DER

Post covid –
every home is
an office

Resiliency Options

Design Decisions

Enhanced vegetation management

Improved storm response practices

Proactive undergrounding

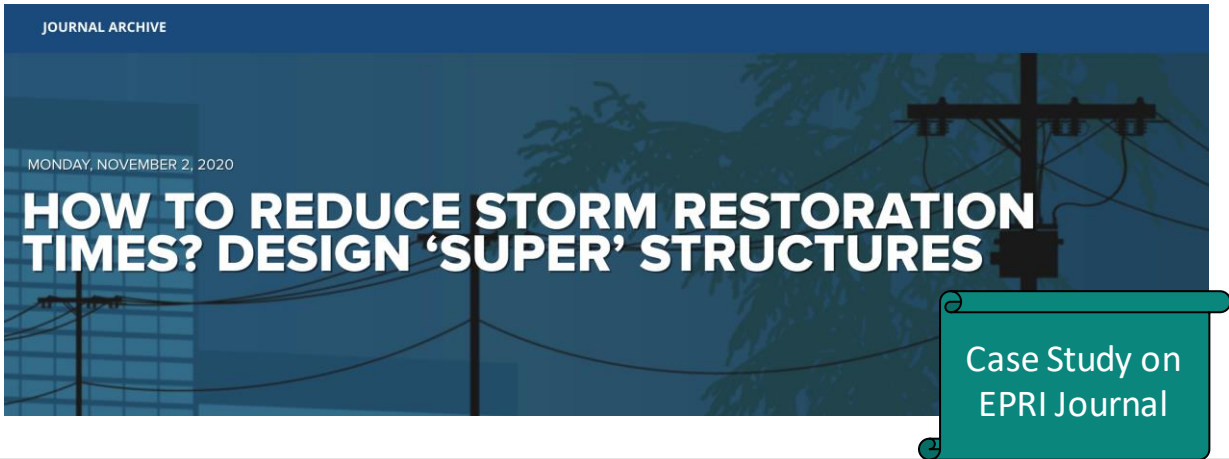


What can we learn from resilience of Overhead?



Small design changes can have large impact

Lab testing can identify practical changes that could have large impact



Goal

- Reduce restoration time through improved distribution designs

Approach

- Specialized full-scale test site at EPRI's Lenox Lab simulates tree strikes

Progress

- More than 75 structures tested for 12 utilities

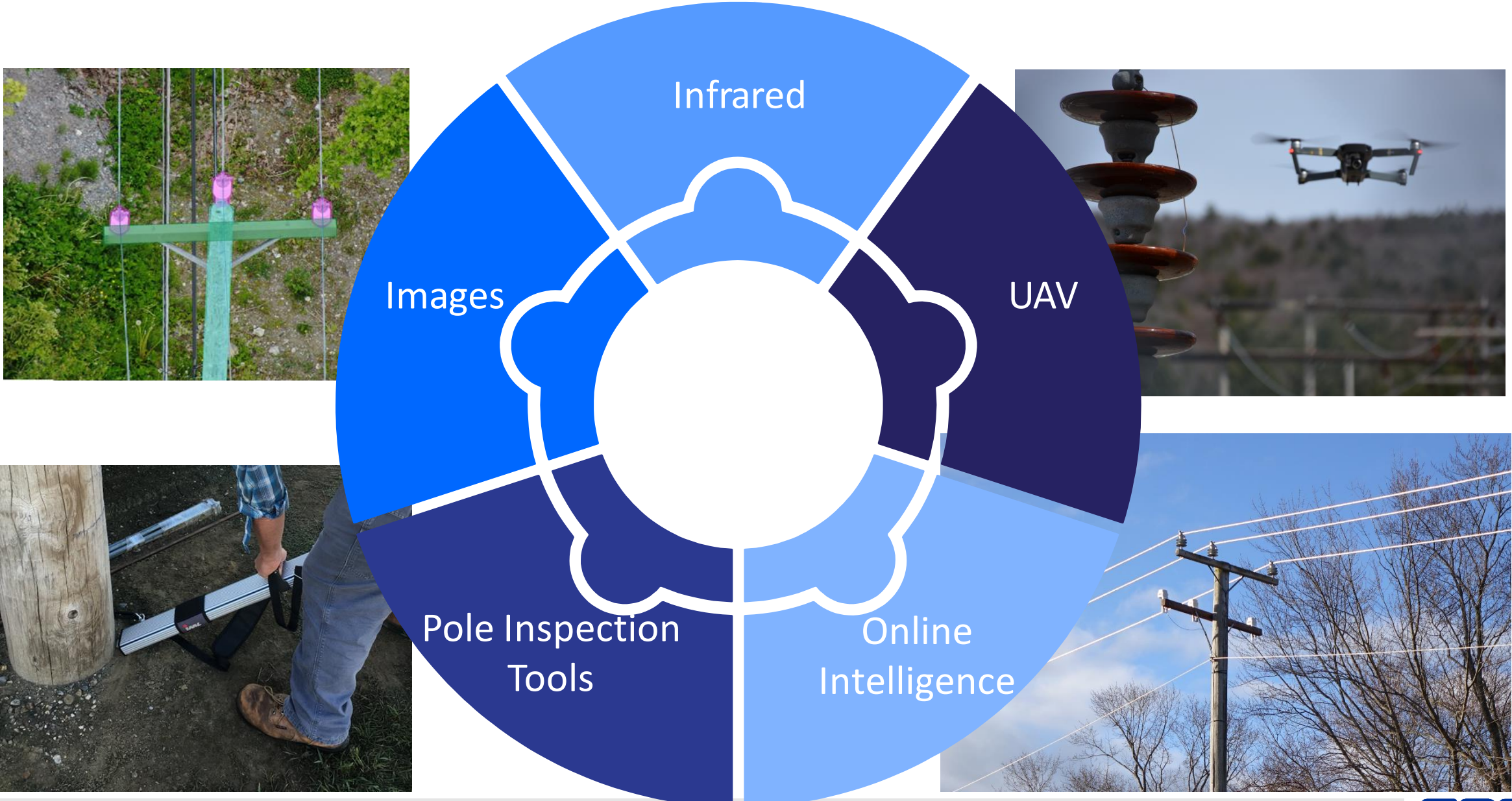
Impact

- Single utility improved 13 standards and created 8 new standards, projecting >10% improvement in SAIDI



The system WILL be stressed

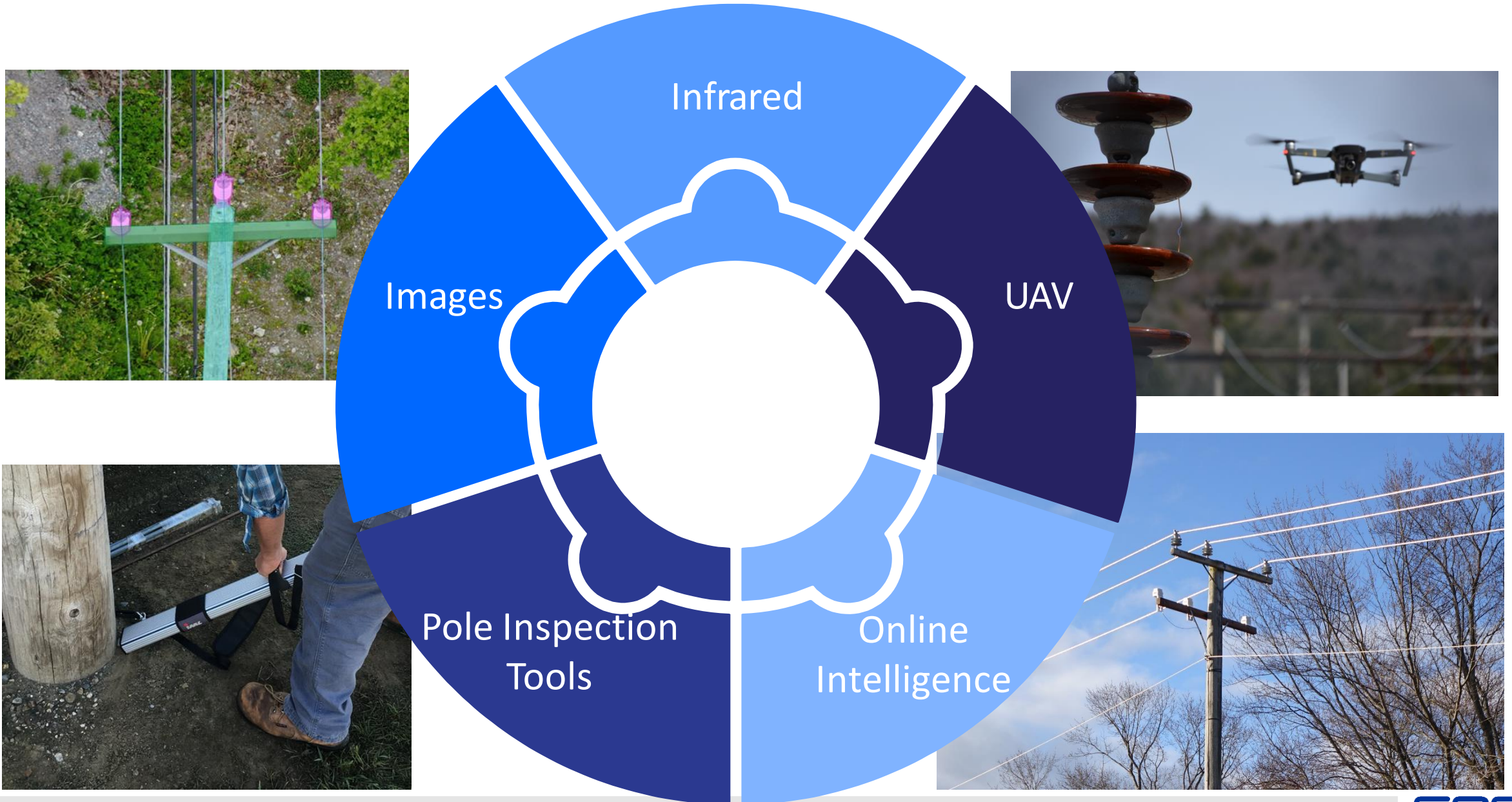
Robust inspection programs are key to resilience





Asset lifespans can be LONG

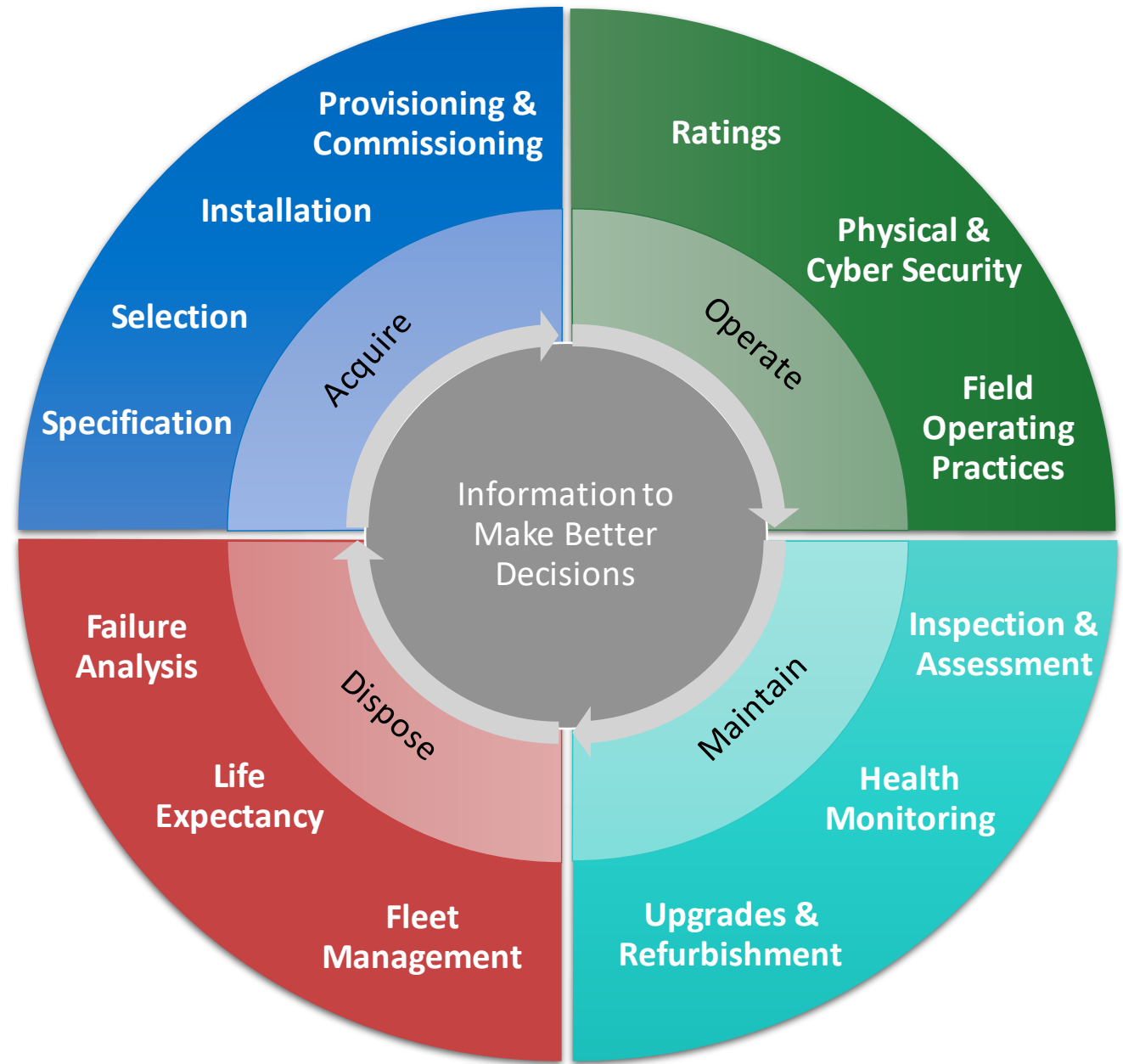
Ability to incorporate new technologies is critical



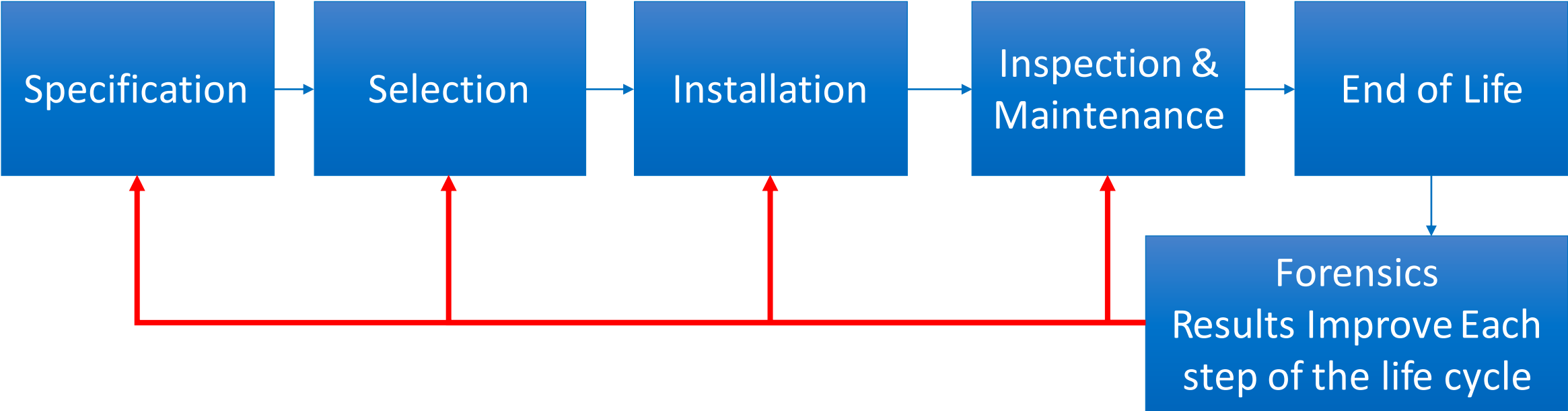


Consider the life-cycle

Asset Lifecycles



Forensic analyses help to improve the life-cycle



Robust, realistic laboratory testing is critical



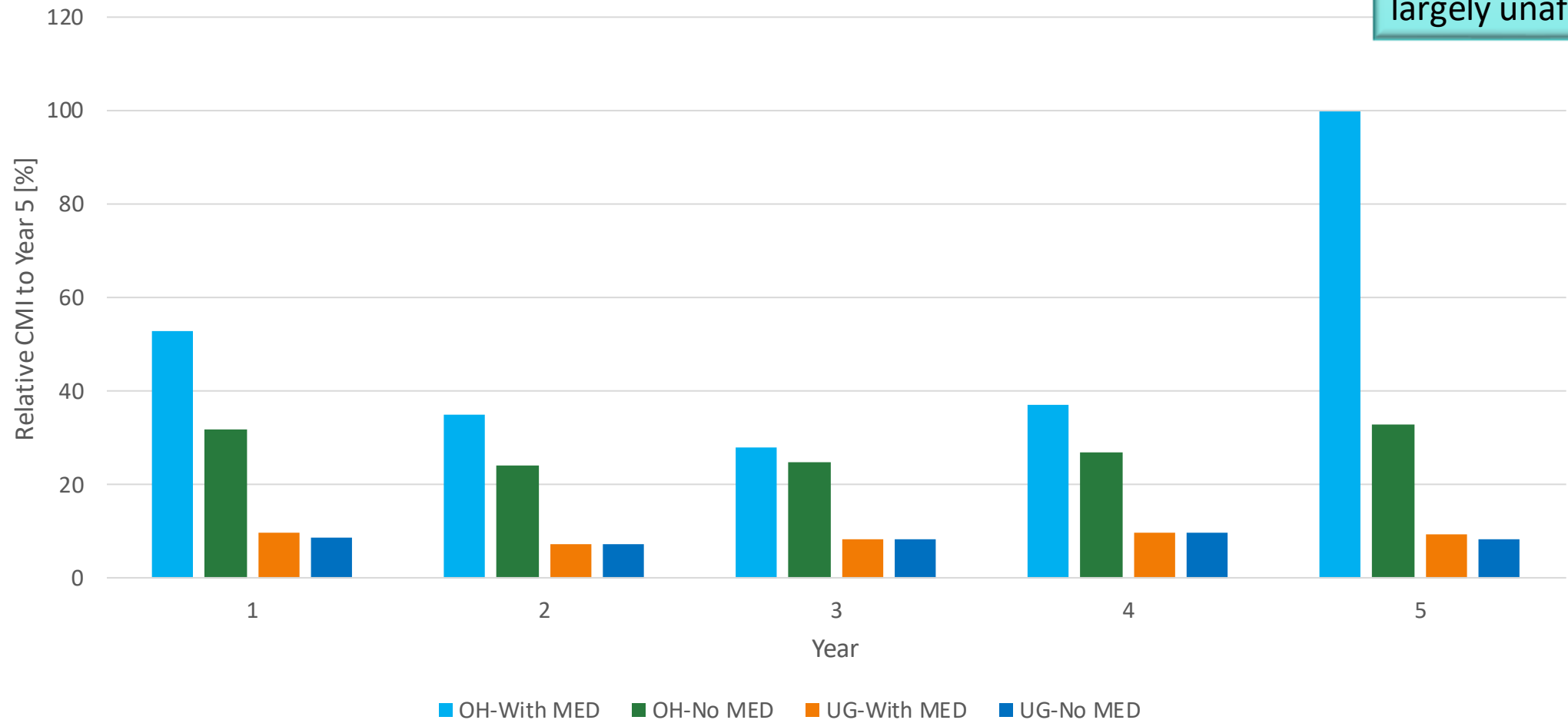
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Underground vs Overhead

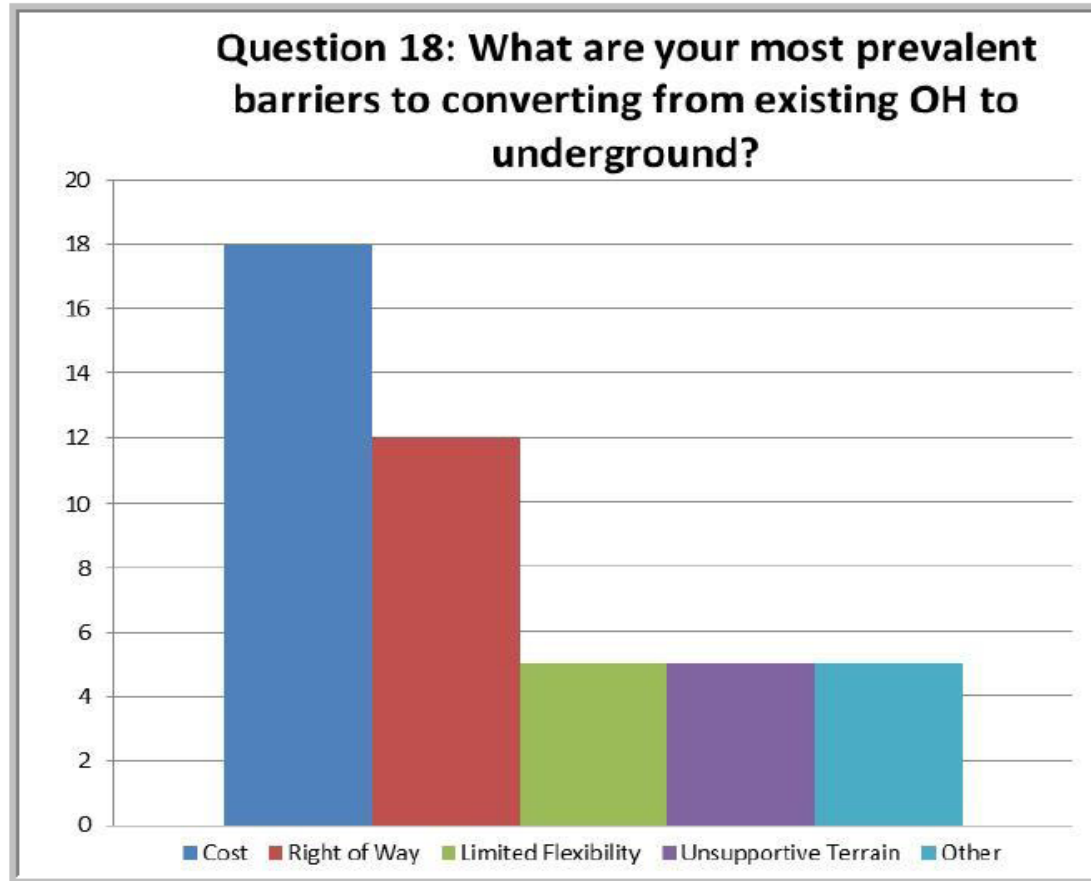
Customer Minutes of Interruption (CMI)
Contributions by System

Overhead systems vulnerable to major event days (MED) while underground systems are largely unaffected



Undergrounding Challenges

2015 Survey



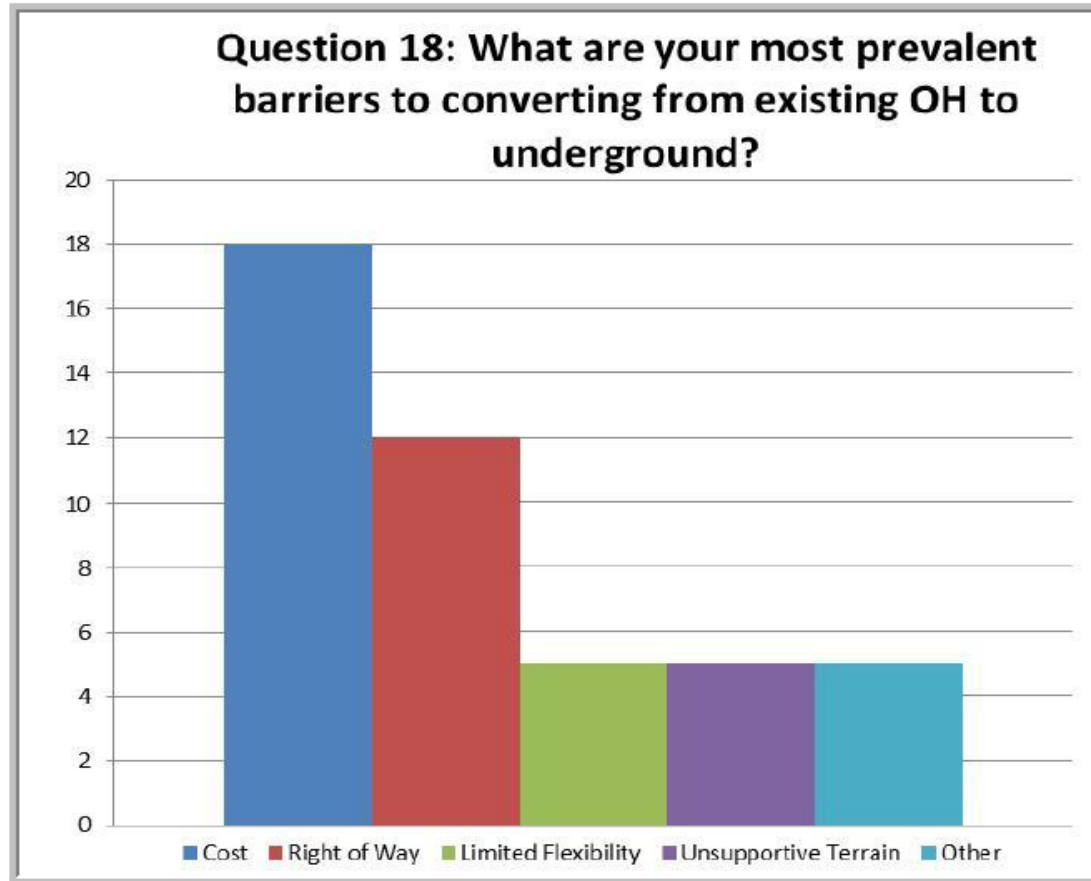
2022 U-DIG Survey



Cost continues to be leading challenge in proactive undergrounding

Undergrounding Challenges

2015 Survey



2022 U-DIG Survey



Cost continues to be leading challenge in proactive undergrounding

Proactive Undergrounding

| | Average | Range |
|---------------------------------------|---------|---------------|
| Urban areas: 150+ customers/mile | \$1.9M | \$180k - 8M |
| Suburban: 51 to 149 customers/mile | \$1.1M | \$165k - 2.5M |
| Rural: <51 customers/mile | \$900k | \$145k - 2M |

Based on 2013 survey
<https://www.epri.com/research/products/3002006782>

EPRI is currently hosting a utility interest group focused on undergrounding

- Sharing of cost reduction strategies
- Discussions of new technologies & installation practices
- Better understanding of optimal undergrounding project design
- Provide a centralized repository of information for members
- Identification and prioritization of R&D needs

<https://distribution.epri.com/u-dig/>



U-DIG Participation

347

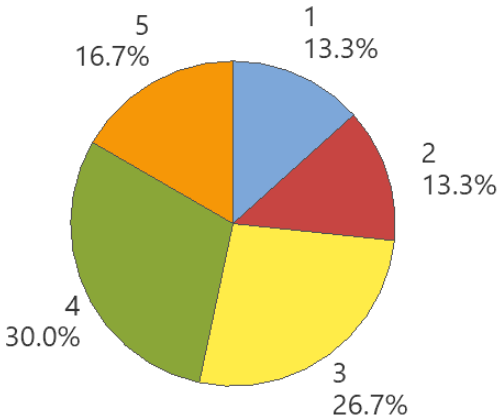
Utility Participants to date
from

50+

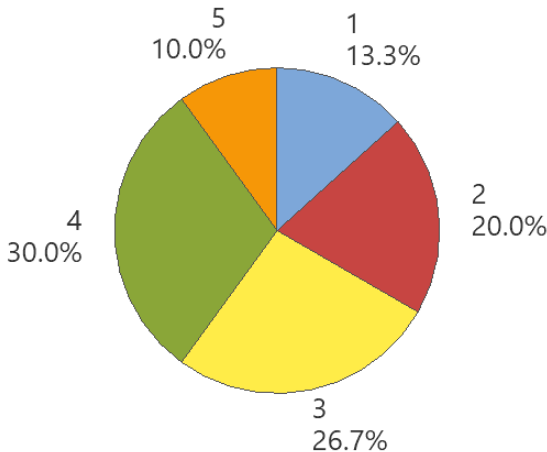
Utilities

Utility Interests for Undergrounding

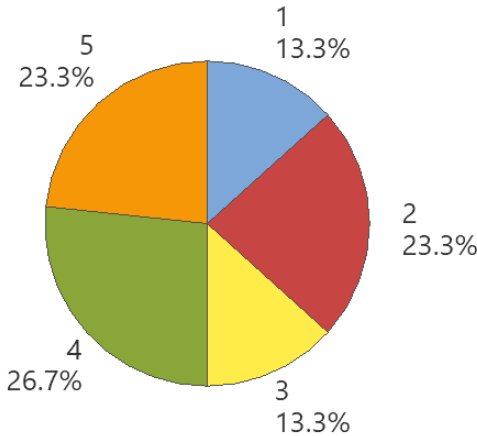
Identify / develop repair technologies



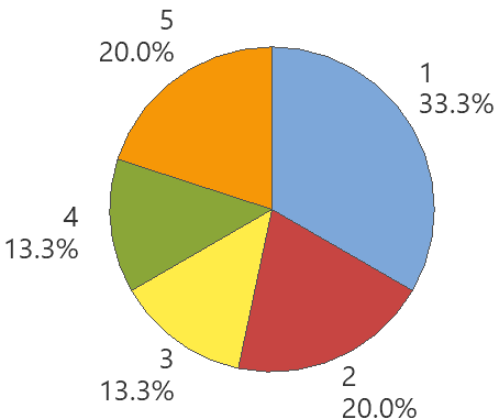
Improve sensing and awareness of existing UG infrastructure



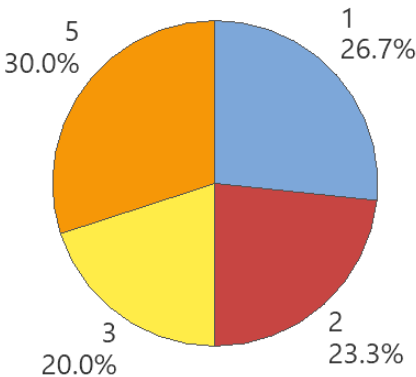
Incorporate health diagnostics, prognostics, and fault location



Reduce civil work required



Reduce errors in UG installation



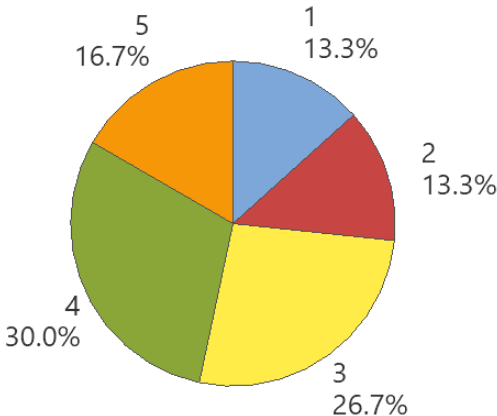
Ranking

1 = Highest importance

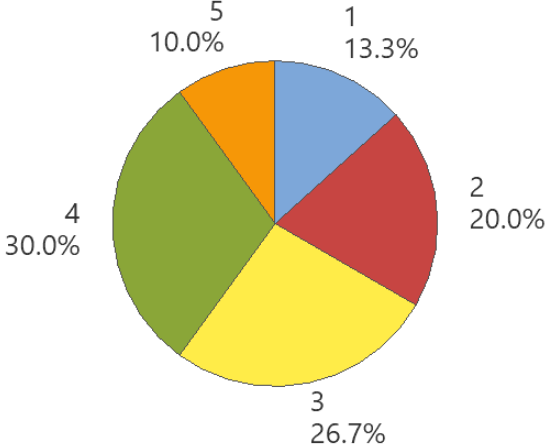
5 = Lowest importance

Utility Interests for Undergrounding

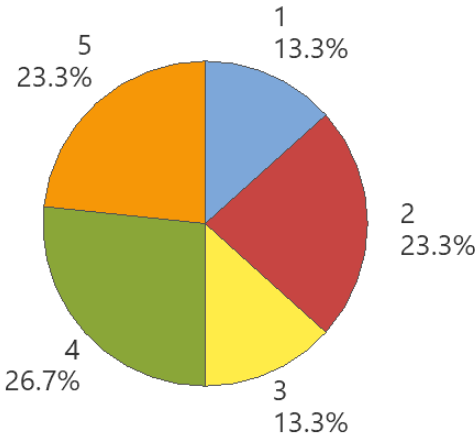
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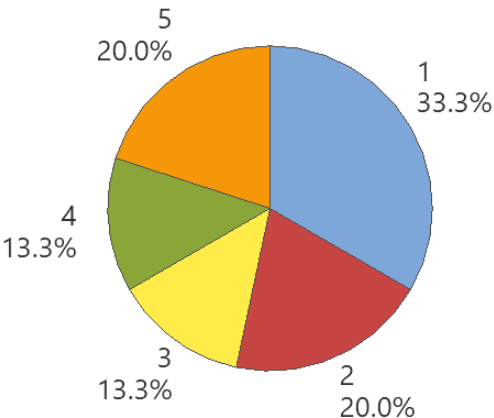
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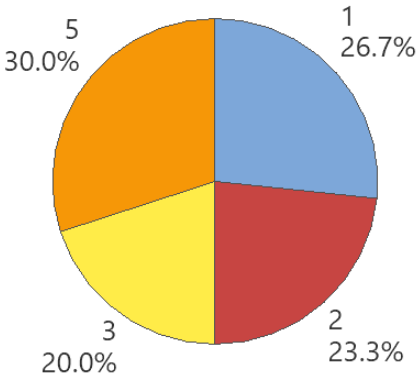
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1 = Highest importance

5 = Lowest importance

Looking ahead

- The future distribution system will likely require increased rates of undergrounding
- In the short term – technology is needed to enable undergrounding to be:
 - Fast
 - Cost-effective
 - Safe
- In the long-term – UG systems should leverage R&D to remain healthy with continued performance improvements



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